Impact of E-Schooling on Digital Eye Strain in Coronavirus Disease Era: A Survey of 654 Students

Richa Gupta[1], Lokesh Chauhan[2], Abhishek Varshney[3]

[1]Department of Glaucoma, CL Gupta Eye Institute, Moradabad, Uttar Pradesh, India, [2]Department of Clinical and Public Health Research, CL Gupta Eye Institute, Moradabad, Uttar Pradesh, India, [3]Department of Vitreoretina, CL Gupta Eye Institute, Moradabad, Uttar Pradesh, India

Abstract

Purpose: To assess digital eye strain (DES) among schoolchildren during lockdown.

Methods: An online questionnaire-based, cross-sectional study was conducted. A validated, self-administered, electronic questionnaire was circulated among students of 5–18 years of age. The duration of data collection was from May 18, 2020 to May 24, 2020. Rasch-based Computer-Vision Symptom Scale was deployed to measure the DES.

Results: A total of 654 students (mean age: 12.02 ± 3.9 years) completed the survey. The average per day digital device exposure was 5.2 ± 2.2 h. A total of 507 (92.8%) children reported experiencing at least one asthenopic/dry eye symptom (AS/DS). The most prevalent symptoms were eye redness (69.1%) and heaviness of eyelids (79.7%). Significant positive correlation was reported between age and per day duration of digital device exposure (Pearson correlation 0.25; $P < 0.001$). Computer vision syndrome (CVS) score for spectacle users was significantly higher ($P < 0.001$). CVS score was found to correlate significantly with age and duration of digital device exposure ($P < 0.001$).

Conclusion: Most of the students surveyed, experienced at least one symptom of DS or AS, indicating a need to educate them about the possible deleterious effects and help them adapt to the currently evolving education system.

Keywords: Asthenopia, COVID-19, Digital eye strain, Dry eye symptoms, E-schooling

INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 infection-associated respiratory disease-COVID-19 (2019-nCoV) has tremendously affected the world and is triggering chaos, fear, anxiety, and stress among people.[1,2] India responded to the pandemic by announcing a nationwide lockdown in March and May 2020, limiting movement of its entire 1.3 billion population.[3] In these extraordinary times, it is a challenge to facilitate standard teaching and training modules for school-going children. As it became vital to maintain social distancing in order to triumph over the pandemic, the use of online virtual classes gained massive popularity. Online education is conducted in two ways. The first is through the use of prerecorded classes, which, when opened out to public, are referred to as Massive Open Online Course. The second one is through live online classes conducted as webinars or Zoom (Zoom Video Communications, Inc., USA) sessions, which allow the advantage of an interactive exchange in real time. While faculty grapples with creating content and delivery systems that harness and utilize technology to its fullest, students are left clinging on to their mobile phones and computer screens.

Moreover, the nation-wide lockdown to curb the spread of coronavirus pandemic restricted 1.3 billion people of India

in their homes, translating to more television (TV) time.[4] The viewership has grown not only in volume, but also in the average time spent per viewer, with the homebound kids leading the surge (46%).[5] This comes despite time spent on smartphones growing 25% in the lockdown period.[5] With the considerable increase in visual display terminals (VDT) usage and subsequent screen time, it is expected to see a surge in ocular symptoms such as irritation, eye strain, and blurring, collectively termed as Computer vision syndrome (CVS) or digital eye strain (DES). The American Optometric Association has defined CVS as a complex of eye and vision problems related to near work, as is experienced during or as a consequence of computer use.[6]

Although CVS has been extensively studied in adults,[7,8] there is a definite paucity of literature on its effects in children. The current study was undertaken to evaluate the effect of VDT usage pattern in school-going children and to assess the prevalence of CVS during the lockdown period in COVID-19 era.

METHODS

The study was a cross-sectional survey of students/parents in India. The study was approved by the institutional ethics committee and followed the tenets of the Declaration of Helsinki for biomedical research. Informed consent was obtained from parents of all study participants. A self-administered, electronic questionnaire (Google Forms) with a cover letter explaining the aim of the study was distributed through WhatsApp (Facebook, Inc., USA) on phone numbers registered with the school database, followed up with two reminder telephonic calls. Students of Grade I-XII, in the age group of 5–18 years were included in the study. Invitations were sent to phone numbers registered with schools for online classes. Two follow-up telephonic reminders were made to maximize study participation. Schools were selected through convenient sampling. Apart from demographic details (age, gender, and school grade), participants were questioned about symptoms related to CVS experienced during the period of lockdown. Other details such as spectacle use, online class participation, and duration of watching TV were also captured for every respondent. Forms with incomplete responses were excluded. The duration of data collection was 1 week (May 18, 2020 to May 24, 2020).

Study questionnaire

In this study, a self-administered, validated, and reliable census – The Computer-Vision Symptom Scale (CVSS17) was used to measure DES subjectively.[9] As far as we are aware, this is the only Rasch-based CVS-related scale to assess visual and ocular complaints in computer users. Rasch method has been recommended for the development of these subjective tools.[10] The questionnaire had 17 questions with different rating scales to obtain information about 15 different symptoms concerning asthenopia symptoms (AS) (eye pain, headache, difficulty in focusing near vision, heavy eyelid, and

eye strain) and dry eyes symptoms (DSs) (red eyes, burning, blinking, stinging, and light sensitivity). Each symptom was graded into four categories (never, rarely, frequently, and always). Two questions had two, 11 had three, and 4 had 4 response categories, respectively. The final CVS score was calculated on the basis of Rasch-based rating chart, available in annexure II. Using this questionnaire, the final CVS score of an individual could vary from 17 to 53. A higher CVS score meant more DES.

Sample size

The sample size was calculated by the formula: $n=Z^2P(1-P)/d^2$; where n = sample size, Z = Z statistic for a level of confidence (95% = 1.96), P = expected prevalence or proportion (proportion of one; 50%, $P = 0.5$), d = precision (in proportion of one; 5%, $d = 0.05$).[11] Using this formula, the sample size was estimated to be 384.

Statistical analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) software, version 21 (IBM, United State). Demographic data were presented as mean, standard deviation, and percentage. For comparison, age, class, and duration of exposure to digital device of student were grouped into different categories. Comparison of CVS score among gender and spectacle use was done using independent *t*-test. Levene's test was used to assess the equality of variance among independent groups. Comparison of CVS score among age, class, and duration of exposure to digital device was done using one-way analysis of variance (ANOVA). For multiple comparison, Fisher's least significant difference (LSD) *post hoc* analysis was performed. Cross tabulation, Chi-square test, or Fischer's exact test were used to compare categorical variables.

RESULTS

A total of 1219 invitation for participation were sent to phone numbers registered with the school for online classes. Of them, 654 (53.6%) students responded to all questions. The mean age of students was 12.02 ± 3.9 years, and 332 (50.8%) were females. The maximum number of students belonged to the age group of 14–16 years (190 [29.1%]), followed by 8–10 years (153 [23.4%]), 11–13 years (109 [16.7%]), 5–7 years (104 [15.9%]), and ≥16 years (98 [15%]). The age and gender distribution are presented in Table 1. A total of

Table 1: Age and gender distribution

Age (years)	Gender		Total
	Female	**Male**	
5-7	43	61	104
8-10	68	85	153
11-13	68	41	109
14-16	107	83	190
>16	46	52	98
Total	332	322	654

234 (35.8%) students were using refractive aids in the form of spectacles. We did not find any child using contact lenses. There was no statistical disparity of refractive error between the genders ($P = 0.18$), a significant association was noted between age and refractive error ($P = 0.00$). Of all, 242 (37%) were students of Grade 1–5, 172 (26.3%) of Grade 6–9, and 240 (36.7%) of Grade 10–12. The average duration of per day digital device exposure was 5.2 ± 2.2 h. The distribution of type of digital devices is presented in Figure 1.

Asthenopic and dry eye symptoms

The most prevalent DS was eye redness (69.1%), followed by eye strain (68.2%), blinking (57.8%), blurred vision (56.9%), light sensitivity (56%), stinging (47.1%), and burning in 46.3%. Of all, 79.7% of the respondents reported heaviness of eyelids as the most frequent asthenopic symptom (AS), followed by heaviness of eye (69.7%), eye pain (62.7%), and difficulty in focusing on near work in 41.9%. The distribution of AS and DS according to class groups is presented in Table 2.

A total of 507 (92.8%) children reported experiencing at least one AS/DS, their average age being 12.3 ± 3.8 years. In contrast, children without any AS/DS belonged to younger age group, with a mean age of 7.4 ± 2.1 years (mean difference 4.94, 95% confidence interval [CI]: 3.8–6.1, $P < 0.001$). Furthermore, 30 (12.5%) children with digital device exposure duration of < 4 h, 13 (6.6%) with exposure between 5 and 6 h, and 4 (2.3%) children with exposure of more than 6 h had not reported any AS ($P = 0.001$). Of all, 7 (2.9%) children using spectacle did not report any AS/DS, compared to 40 (9.5%) children who were not using spectacle ($P = 0.002$). Heavy eyelid, eye redness, eye strain, and heaviness of eyes remained the most frequently reported symptoms.

Computer vision syndrome score (questionnaire score)
Correlation

The average CVS score of students was 26.9 ± 7.4. The distribution of individual CVS scores is presented in Figure 2. There was a significant positive correlation between age and per day duration of digital device exposure (Pearson

correlation: 0.25; $P < 0.001$). Similarly, there was statistically significant correlation of CVS score with daily duration of digital device exposure (Pearson correlation: 0.31; $P = 0.00$) and age (Pearson correlation: 0.17; $P < 0.001$).

Group comparison

We did not find any significant difference of the mean CVS score between male students (27.2 ± 7.7) and female students (26.6 ± 7.2) ($P = 0.61$). The mean CVS score of spectacle users was 27.9 ± 7.3 as against students not using spectacles 26.3 ± 7.4 ($P = 0.009$).

Age of student

The mean CVS score differed significantly between age groups, as determined by one-way ANOVA (F [4, 649] = 8.09, $P < 0.001$) [Table 3]. LSD *post hoc* test revealed that the mean CVS score was statistically significantly lower in the 5–7-year group as compared to older children (11–16 years [$P = 0.004$] and more than 16 years [$P < 0.001$]). Similarly, a statistically lower mean CVS score was reported in 8–10 years group as compared to 11–13 ($P = 0.037$), 14–16 ($P = 0.076$), and more than 16-year group ($P = 0.001$) [Figure 3].

Student grade

Mean CVS score of class group 1–5 was 26.1 ± 7.8, 24.8 ± 6.6 in class group 6–9, and 29.1 ± 7.1 in class group 10–12, respectively. There was a statistically significant difference between class groups as determined by one-way ANOVA (F [2, 561] =20, $P < 0.001$) [Table 3]. LSD *post hoc* test showed a statistically significantly lower mean CVS score in class 1–5 as compared to 10–12 ($P < 0.001$). Statistically significant difference was also found in mean CVS score between class 6–9 and 10–12 ($P < 0.001$).

Digital device exposure

For comparison, the total duration of digital device exposure was grouped into three categories: namely, ≤ 4 h ($n = 269$, 41.1%), 5–6 h ($n = 209$, 32.0%), and more than 6 h ($n = 176$, 26.9%). The mean CVS score was lowest in ≤ 4 h groups (25.0 ± 6.5), followed by 4–6 h (26.6 ± 7.1) and >6 h (30.1 ± 8.1). One-way ANOVA determined statistically significant difference of mean CVS score among different groups (F [2, 651] = 27.5, $P < 0.001$). *Post hoc* analysis revealed the mean difference of 1.5 (95% CI: 0.2–2.9; $P = 0.016$) between ≤ 4 h and 5–6 h, 5.1 (95% CI: 3.7–6.5; $P < 0.001$) between ≤ 4 h and >6 h, and 3.5 (95% CI: 2.1–4.9, $P = 0.00$) between 5–6 h and >6 h [Figure 4].

Discussion

The pandemic of COVID-19 has forced schools and universities not only in India, but also around the world, to suspend physical classrooms and shift to online classes. While countries are at different points in their COVID-19 infection rates, globally there are currently more than 1.2 billion children in 186 countries affected by school closures due to the pandemic.[12] Connecting teachers with students through digital platforms and necessary software through the use of laptop or
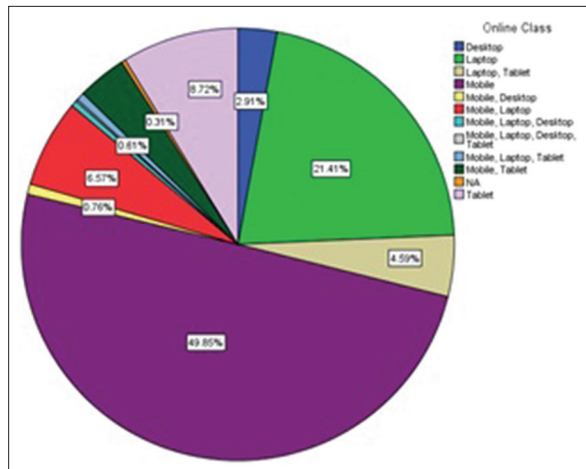

Figure 1: Pie chart showing the distribution of type of digital device use

Table 2: Distribution of dry eye and asthenopia symptoms

Category	Symptom	Yes/no	Class (%)			P
			1-5	6-9	10-12	
Dry eye symptom	Blurred vision	No	207 (85.5)	75 (43.6)	0	<0.001
		Yes	35 (14.5)	97 (56.4)	240 (100)	
	Burning	No	111 (45.9)	99 (57.6)	93 (38.8)	0.001
		Yes	131 (54.1)	73 (42.4)	147 (61.3)	
	Eye strain	No	92 (38.0)	69 (40.1)	47 (19.6)	<0.001
		Yes	150 (62.0)	103 (59.9)	193 (80.4)	
	Blinking	No	99 (40.9)	85 (49.4)	92 (38.3)	0.07
		Yes	143 (59.1)	87 (50.6)	148 (61.7)	
	Stinging	No	137 (56.6)	111 (64.5)	98 (40.8)	<0.001
		Yes	105 (43.4)	61 (35.5)	142 (59.2)	
	Light sensitivity	No	121 (50.0)	99 (57.6)	68 (28.3)	<0.001
		Yes	121 (50.0)	73 (42.4)	172 (71.7)	
	Eye redness	No	102 (42.1)	63 (36.6)	37 (15.4)	<0.001
		Yes	140 (57.9)	109 (63.4)	203 (84.6)	
Asthenopia symptom	Eye pain	No	111 (45.9)	74 (43.0)	59 (24.6)	<0.001
		Yes	131 (54.1)	98 (57.0)	181 (75.4)	
	Heaviness	No	93 (38.4)	51 (29.7)	54 (22.5)	<0.001
		Yes	149 (61.6)	121 (70.3)	186 (77.5)	
	Difficult focusing	No	156 (64.5)	112 (65.1)	112 (46.7)	<0.001
		Yes	86 (35.5)	60 (34.9)	128 (53.3)	
	Heavy eyelid	No	70 (28.9)	41 (23.8)	22 (9.2)	<0.001
		Yes	172 (71.1)	131 (76.2)	218 (90.8)	

Table 3: Comparison of computer vision syndrome score among different age and class groups

Variable	Category	n	Mean CVS score±SD	95% CI for mean CVS (lower bound-upper bound)	Minimum	Maximum	P
Age group (years)	5-7	104	25.40±7.89	23.87-26.94	17.0	43.0	<0.001
	8-10	153	26.55±7.52	25.35-27.75	17.0	53.0	
	11-13	109	24.64±6.21	23.46-25.82	17.0	39.0	
	14-16	190	27.96±7.80	26.85-29.08	17.0	53.0	
	>16	98	29.59±6.42	28.30-30.88	18.0	44.0	
	Total	654	26.91±7.47	26.34-27.49	17.0	53.0	
Class	1-5	242	26.16±7.80	25.17-27.15	17.0	53.0	<0.001
	6-9	172	24.83±6.64	23.83-25.83	17.0	53.0	
	10-12	240	29.17±7.11	28.27-30.08	18.0	53.0	
	Total	654	26.91±7.47	26.34-27.49	17.0	53.0	

CVS: Computer vision syndrome, SD: Standard deviation, CI: Confidence interval

phones is the latest transition in education trying to eradicate the physical need of teachers or classrooms. The daily active base has jumped across video conferencing platforms including Skype (Skype Technologies. USA), Hangouts (Google Inc. USA), and Zoom (Zoom Video Communications, Inc., USA). As people are compelled to take shelter indoors, TV viewership has spiked in unprecedented ways.[13]

Furthermore, the growth has been driven by younger audiences; viewership in the 2–14-year group has risen by 20%, followed by 15–21 years (7%).[14] Furthermore, the 2–14 year olds are not just consuming kids content, their viewership of news (83%) and movies (24%) has increased, too,[15] pointing to the seminal trend of the TV being a key source of entertainment to many in the country.

With this unforeseen upsurge in information technology, on account of the prevailing cataclysmic circumstances, the need for research into computer-associated health disorders cannot be overemphasized. While the symptoms may be transitory, CVS or DES can cause a significant distress to the sufferer, particularly children. Prolonged exposure to digital devices may cause an array of clinical symptoms related to asthenopia and dry eyes.[14] In addition, extraocular symptoms involving the musculoskeletal system and peripheral nervous system have also been reported.[16]

There are many questionnaires available for subjective assessment of DES. The study questionnaire, the CVSS17 was selected because it has been developed by Rasch-based analysis and is more recent. The 17 questions with different rating
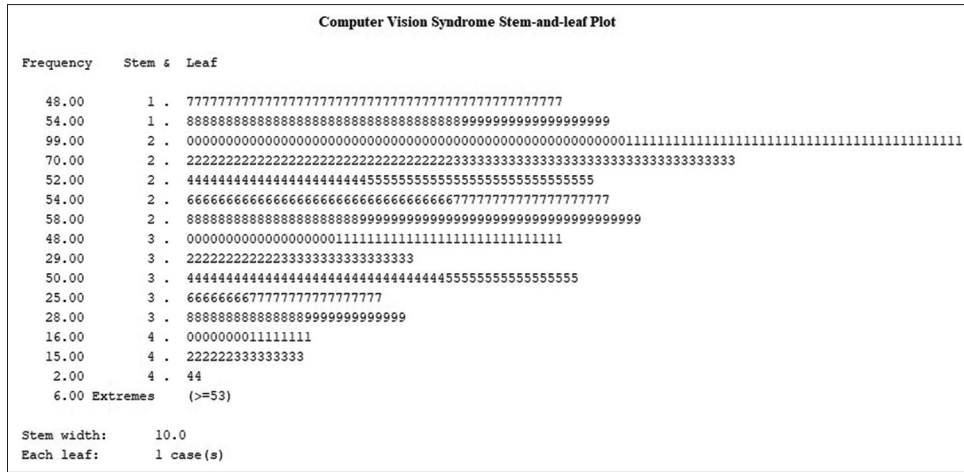
Figure 2: Stem and leaf plot showing distribution of individual computer vision syndrome score
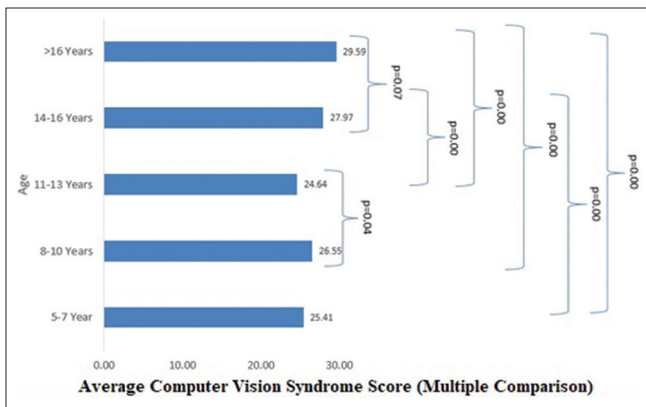

Figure 3: Mean computer vision syndrome score among different age groups
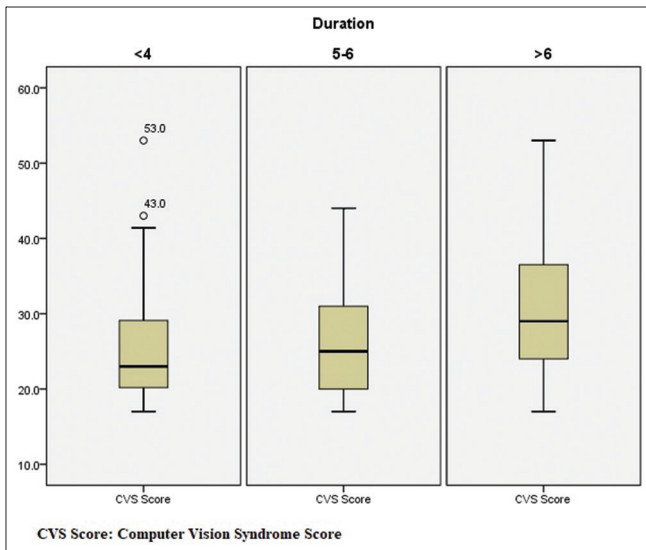

Figure 4: Box plot showing computer vision syndrome score distribution according to duration of digital device use

scales were centered on the symptoms associated with CVS. Published literature identifies external symptoms of burning, irritation, tearing, light sensitivity, and dryness to be closely related to dry eye, while internal symptoms of strain, eye ache, headache behind the eyes, blurred vision at near, blurred distant vision after computer use, and difficulty in refocusing from one distance to another linked to ocular fatigue.[14,16,17] We split the symptoms of the questionnaire, categorized, and analyzed them for our subject population in a similar fashion, which has been elaborated further.

An image on the computer screen is formed by coalition of tiny dots called pixels, which are the result of electronic beam striking the phosphor-coated rear surface of the screen. Each pixel has a bright center, which fades toward the periphery. This makes it difficult for human eyes to sustain focus on the pixel characters on the screen, leading to eye strain and fatigue.[18,19] This is a matter of concern as in children, there is a limited degree of awareness, and they keep performing an enjoyable task for hours, with few, if any, breaks.[18]

In our study, the age of asymptomatic students was significantly less than students with at least one AS. Furthermore, higher exposure was noted in older children, which further reflected positively in the AS during lockdown. These findings are in accordance with previous studies,[16,17] which have shown that even a short exposure of 1 h to VDT leads to a compulsive sustained accommodative effort, reduction in amplitude of accommodation due to accommodative fatigue, increased accommodative innervation, receding of near point of convergence, increase in near lateral exophoria, and onset of subjective visual fatigue. Furthermore, a small amount of myopic shift has been objectively recorded by various studies on near work-induced transient myopia,[18] and its delayed decay among early onset myopes may be factors of consideration for contribution in the development of permanent myopic changes among adults.[19]

In their study of 216 Swedish school children, Abdi *et al.*[20] found a significant association of asthenopia with uncorrected visual acuity of ≤0.65 and with myopia (spherical equivalent −0.50 diopter or less). Although Vilela *et al.*,[21] in their meta-analysis, did not find a majority of asthenopic

children with abnormalities of visual acuity or refraction, we noted that the students who were using spectacle experienced more ASs as compared to students who were not using spectacles. Previous studies have also reported that students with refractive error require greater active accommodation and convergence to compensate for their refractive error at near and hence are more likely to experience asthenopia.[22]

Conditions of high illumination, glare, and reflections on VDT have been reported to escalate the symptoms of CVS.[18] Children, in general, are tolerant and adaptive to their problems. A child viewing a digital screen with increased glare may not think of adjusting the brightness, resulting in excessive eye strain.[18]

Blinks are imperative in maintaining the physiologic milieu of the tear film on the ocular surface. An adequate functioning demands both appropriate frequency and completion of the blinking action. An increase of cognitive demand and attention to a visual task commonly seen with VDT use lead to increased blink interval and reduced blinking[23] up to 1/4 to 1/3 of the basal rate.[24] Furthermore, computer workstations are designed for adult use and are located higher in the field of vision than traditional paperwork. Hence, a child must often look up further than an adult, resulting in an increased exposure of surface area for tear evaporation, aggravating the symptoms of dry eyes.[18] In the present study, ocular complaints such as stinging, burning, and redness were present in higher percentages in students of higher grades, demanding an extended digital screen exposure with infrequent breaks. Similar findings have been reported by Moon *et al.*[24] in their series of 916 children, where they found 9.1% of children in older grade (4th–6th) to have dry eye disease compared to 4% in younger grade group (1st–3rd), and long duration of smartphone use with shorter outdoor activity time was a major risk factor.

In another case–control study by the same authors, smartphone use was found to be more common in the dry eye disease group (71%) than the control group (50%).[25] The daily duration of smartphone use and total daily duration of VDT use were associated with increased risk of dry eye, but increased computer and TV use did not increase the risk of dry eye disease. Furthermore, studies have shown a positive correlation of lid margin abnormality, meibum expression, and meibomian gland dropout (indicators of meibomian gland dysfunction) with VDT usage time of more than 4 h per day.[26]

The prevalence of CVS in various studies has been reported to be 9.1%–23.1%. The largest series is a cross-sectional population based study of 1448 young children aged 6 years. The authors reported an estimated prevalence of eye strain as 12.6%, and a poor correlation with refractive error, amblyopia, or strabismus. We saw a significantly higher occurrence of the same, i.e., 92.8%, most probably a result of increased digital exposure due to online classes and surged TV viewing during lockdown.

Furthermore, the most common symptoms, as reported in previous literature were eye strain, headaches, and blurred

vision. However, we found most of the respondents complaining of heaviness (79.7%) and redness of eyes (69.1%).

In our study, student's age, duration of digital device exposure, and CVS score were found to be significantly correlated. Students studying in lower grades were found to have significantly lower CVS score and prevalence of AS and DS than students in higher grades. This further confirms the above finding since student's age and class are highly correlated.

The DES reported in our study was not gender dependent as the mean CVS score among male and females was not differed significantly. The CVS score of student using spectacles was significantly higher. Furthermore, in our study, students in lower age group, studying in lower grades with lesser exposed duration of digital devices had significantly lower CVS score as compared to others.

The tremendous power of virtual classrooms is their ability to deliver endless knowledge at students' doorsteps. With an increase in digital device usage, a surge in resultant ocular affliction is inevitable. Preventive and therapeutic interventions include treatment of dry eyes using lubricating eye drops and blink efficiency exercises, using appropriate refraction aids, early detection and management of accommodation and vergence anomalies, modifying the ergonomic placement of screens, and improving the ambient lighting. Uninterrupted VDT exposure is implicated in visual fatigue, ocular and musculoskeletal strain, and in this regard, the role of frequent breaks cannot be stressed more. Furthermore, use of software available to set the screen time limit on children's mobile phone to limit and monitor extra academic browsing may be helpful.

To the best of our knowledge, this is the first study focusing on the emerging trends in learning in COVID era and the impact it is bound to have on the eyes of children.

Our study had some limitations. Self-reporting, as is the format of any survey, can have its own biases. The responses may vary with the level of comprehension of the participants. In addition, without any clinical examination, the accuracy and reliability of the feedback may be dubious, especially in children. There could have been under-reporting, fearing a consequential restriction in VDT usage, or an over-reporting in respondents with a low threshold. The CVSS17 questionnaire has not been validated for this age group. Parents of students have responded for lower age group children. Finally, though the CVSS17 questionnaire is a screening tool and gives CVS scores which can be correlated with disease severity, a clinical examination is imperative in diagnosis and planning an intervention.

In conclusion, the impact of COVID-19 will probably remain for years, if not longer, and the current generation will be defined by their use of technology. Virtual classes are going to be the new normal. Our study draws attention to this changing trend of education and the deleterious effect it can have on the eyes of children, in the form of CVS. There is a need for awareness among the students as they are the ones majorly

impacted by the pandemic and are in the best position to learn and grow from it.

Conflicts of interest
There are no conflicts of interest.

References

1. Sharma S, Sharma M, Singh G. A chaotic and stressed environment for 2019-nCoV suspected, infected and other people in India: Fear of mass destruction and causality. Asian J Psychiatr 2020;51:102049.
2. Torales J, O'Higgins M, Castaldelli-Maia JM, Ventriglio A. The outbreak of COVID-19 coronavirus and its impact on global mental health. Int J Soc Psychiatry 2020;66:317-20.
3. Modi Orders 3-Week Total Lockdown for All 1.3 Billion Indians. Available from: https://www.nytimes.com/2020/03/24/world/asia/india-coronavirus-lockdown.html. [Last accessed on 2020 Jul 30].
4. The COVID-19 Pandemic has Changed Education Forever. This Is How. Available from: https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/. [Last accessed on 2020 Jul 30].
5. Average Time Spent on Smartphone Up 25% to Almost 7 Hours Amid Pandemic: Vivo Report. Available from: https://www.businesstoday.in/technology/news/average-time-spent-on-smartphone-up-25-percent-to-almost-7-hours-amid-pandemic-vivo-report/story/424790.html. [Last accessed on 2021 Jan 20].
6. Daum KM, Clore KA, Simms SS, Vesely JW, Wilczek DD, Spittle BM, *et al.* Productivity associated with visual status of computer users. Optometry 2004;75:33-47.
7. Bali J, Navin N, Thakur BR. Computer vision syndrome: A study of the knowledge, attitudes and practices in Indian ophthalmologists. Indian J Ophthalmol 2007;55:289-94.
8. Mocci F, Serra A, Corrias GA. Psychological factors and visual fatigue in working with video display terminals. Occup Environ Med 2001;58:267-71.
9. González-Pérez M, Susi R, Antona B, Barrio A, González E. The Computer-Vision Symptom Scale (CVSS17): Development and initial validation. Invest Ophthalmol Vis Sci 2014;55:4504-11.
10. Pesudovs K, Burr JM, Harley C, Elliott DB. The development, assessment, and selection of questionnaires. Optom Vis Sci 2007;84:663-74.
11. Daniel WW. Biostatistics: A Foundation for Analysis in the Health Sciences. 7th ed. New York: John Wiley & Sons; 1999.
12. Five Lessons We Must Take from the Coronavirus Crisis. Available from: https://www.weforum.org/agenda/2020/04/5-lessons-from-coronavirus-crisis/. [Last accessed on 2020 Jul 30].
13. Coronavirus Impact: How Video Apps Have Zoomed to Popularity Sans Advertising. Available from: https://www.financialexpress.com/brandwagon/coronavirus-impact-how-video-apps-have-zoomed-to-popularity-sans-advertising/1928905/. [Last accessed on 2021 Jan 20].
14. Amid Covid-19 Lockdown, Time Spent on TV, Smartphone Surges. Available from: https://www.livemint.com/news/india/covid-19-lockdown-tv-viewing-time-up-by-8-smartphone-usage-by-6-11585304359013.html. [Last accessed on 2020 Jul 30].
15. Portello JK, Rosenfield M, Bababekova Y, Estrada JM, Leon A. Computer-related visual symptoms in office workers. Ophthalmic Physiol Opt 2012;32:375-82.
16. Ferraz MB, Frumkin H, Helfenstein M, Gianeschini C, Atra E, Inoue O, *et al.* Upper-extremity musculoskeletal disorders in keyboard operators in Brazil: A cross-sectional study. Int J Occup Environ Health 1995;1:239-44.
17. Blehm C, Vishnu S, Khattak A, Mitra S, Yee RW. Computer vision syndrome: A review. Surv Ophthalmol 2005;50:253-62.
18. Kozeis N. Impact of computer use on children's vision. Hippokratia 2009;13:230-1.
19. Vasudevan B, Ciuffreda KJ. Additivity of near work-induced transient myopia and its decay characteristics in different refractive groups. Invest Ophthalmol Vis Sci 2008;49:836-41.
20. Abdi S, Lennerstrand G, Pansell T, Rydberg A. Orthoptic findings and asthenopia in a population of Swedish schoolchildren aged 6 to 16 years. Strabismus 2008;16:47-55.
21. Vilela MA, Pellanda LC, Fassa AG, Castagno VD. Prevalence of asthenopia in children: A systematic review with meta-analysis. J Pediatr (Rio J) 2015;91:320-5.
22. Hendricks TJ, de Brabandar J, Horst FV, Hendrikse F. Relationship between habitual refractive errors and headache complaints in school children. Optom Vis Sci 2007;84:137-43.
23. Nakamori K, Odawara M, Nakajima T, Mizutani T, Tsubota K. Blinking is controlled primarily by ocular surface conditions. Am J Ophthalmol 1997;124:24-30.
24. Moon JH, Kim KW, Moon NJ. Smartphone use is a risk factor for pediatric dry eye disease according to region and age: A case control study. BMC Ophthalmol 2016;16:188.
25. Moon JH, Lee MY, Moon NJ. Association between video display terminal use and dry eye disease in school children. J Pediatr Ophthalmol Strabismus 2014;51:87-92.
26. Chu CA, Rosenfield M, Portello JK. Blink patterns: Reading from a computer screen versus hard copy. Optom Vis Sci 2014;91:297-302.